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EXCESS HEAT GENERATION, NEUTRON EMISSION, AND CELL VOLTAGE CHANGE IN D_2O LiOD-Pd SYSTEMS

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ABSTRACT

To elucidate the mechanism of the excess heat generation (EHG), the correlation of the EHG with the nuclear effects, especially the excess neutron emission (ENE), and electrochemical effects, especially the cell voltage (CV) change, is discussed based on the data obtained in a series of electrolysis of heavy water or light water in $D_2(H_2)O$-LiOD(H)-Pd systems.

INTRODUCTION

In previous papers [1,2,3] we discussed the detection of the ENE in the electrolysis of D_2O-LiOD-Pd and of H_2O-LiOH-Pd systems. The conclusion was that the excess neutron has been detected appreciably from the former, but no neutrons from the latter.

In the present work, to discuss the correlation between the ENE and the EHG, we equipped a simple heat monitoring system to our electrolysis cell (Cell). Using the Cell, four electrolysis runs with heavy water and one run with light water have been carried out. Throughout the operation, the electrolyte temperature (ET), the CV and the neutron emission rate were measured and stored into a computer system in every 10 sec. to investigate correlations among the above effects.

EXPERIMENT

The experimental conditions are summarized in Table 1. NaOD was used as the electrolyte in Run 1 and 20% ^{6}Li was used in the form of LiOD in Run 3.

The schematic view of the Cell employed in the present experiment is illustrated in Fig. l. The three thermocouples (TCs) were located in the electrolyte for measuring the ET and the two TCs were placed in the outlet and inlet part of the cooling water. A magnetic stirrer has been employed to diminish the temperature gradient in the electrolyte. The principle of the detection of the excess heat is the same as reported by Takahashi et al. [4]

Run No.	Cathode size (mm)	Electrolyte	Preloading days	Electrolysis cycle	Electrolysis Time (h)	Low /High Current
1	0.5×10.0×25.0	NaOD(0.5M)	5	12 hours /cycle	158	19/355
2	1.0×10.0×25.0	LiOD(0.6M)	9		745	18/333 mA/cm^2
3		20% ^{6}LiOD(0.5M)	7		264	
4		LiOD (0.5M)	10		307	
5		LiOH (0.5M)	—		192	

Table 1. Electrolysis Conditions

The electrolysis experiments were carried out by the L-H mode pulse with 12hr repetition period. The assembly for the neutron detection and the evaluation method of the excess neutron are the same as reported previously. [3]

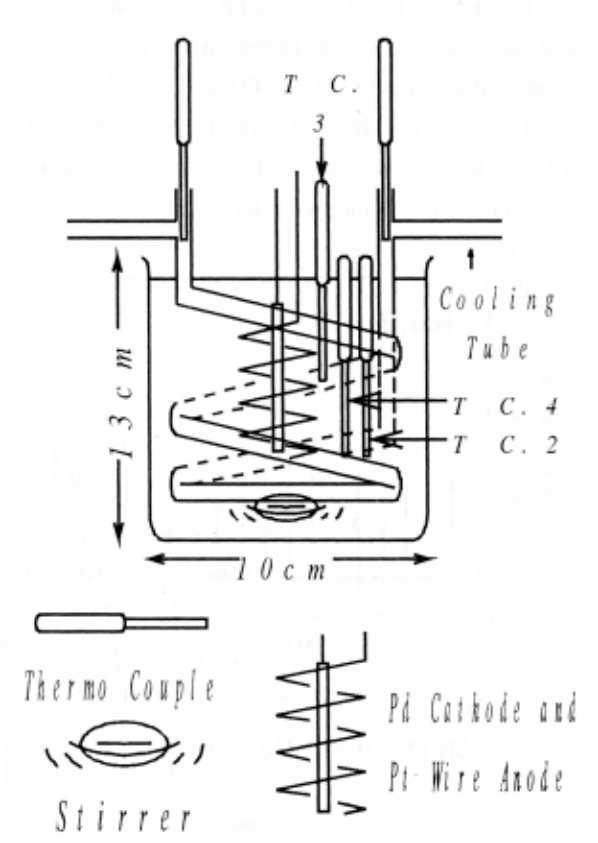

Figure 1. Electrolysis cell

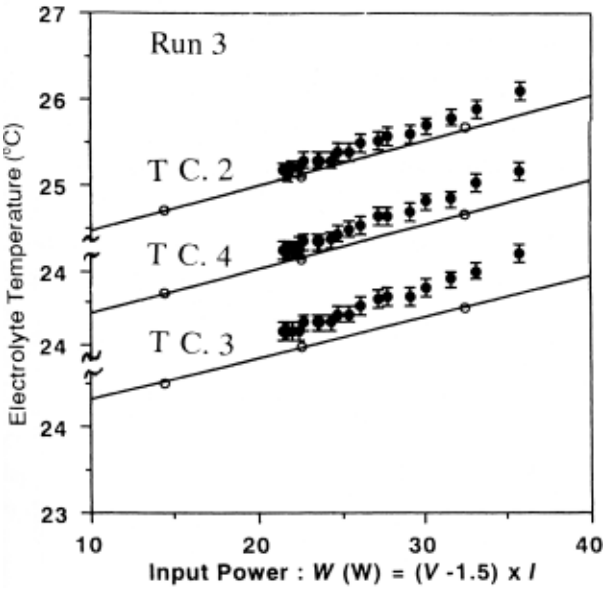

Figure 2. Cell temperature for each thermocouple

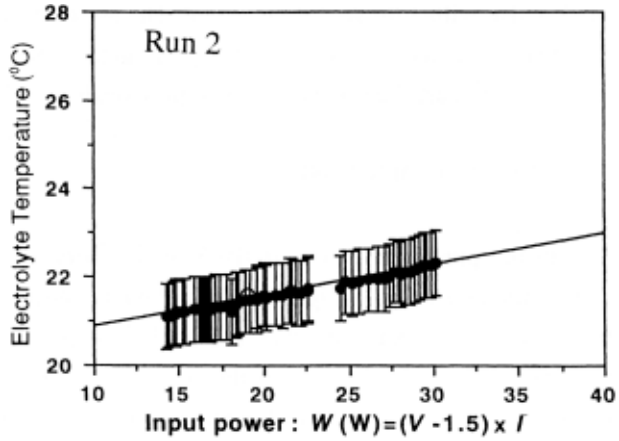

Figure 3. Cell temperature with no excess heat generation

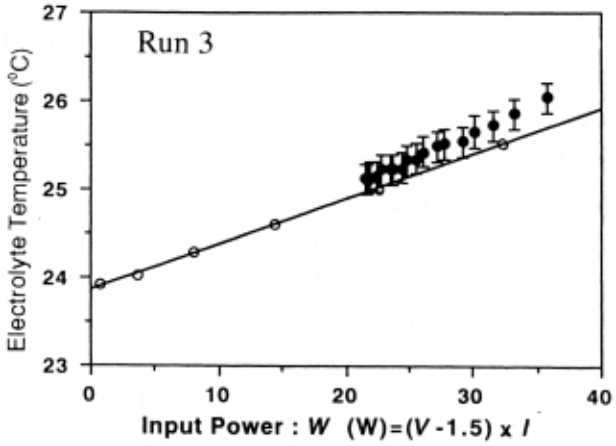

Figure 4. Average cell temperature

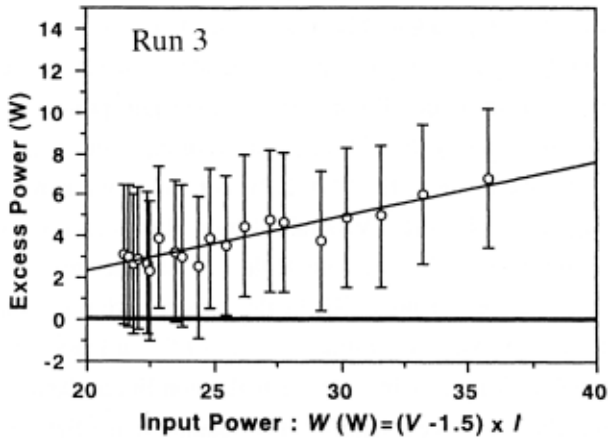

Figure 5. The correlation of excess power to input power

RESULTS AND DISCUSSION

In the present five runs, only Run 3 generated the excess heat as shown in Fig. 2 in which the ETs measured by the three TCs are plotted as a function of the input power (IP). The solid lines with the open circles are the calibration lines. According to the present principle of the excess heat detection, the upward deviations of the ETs from the calibration lines indicate the EHG. A typical example of the same plotting of the ET obtained in Run 2 is shown in Fig. 3 to demonstrate the plot with no EHG. To evaluate the excess energy, the averaged values of these temperatures are plotted in Fig. 4. From these temperatures, the excess energy was calculated at each EP and shown in Fig. 5 as a function of the IP. The generation of the excess energy became appreciable from the point where the IP is about 23W and increases with increase of the IP up to 36W. At this point, the excess energy is evaluated to be 7W and the energy gain to be ca.20%. The CV is defined here as follows; Cell Voltage = V(Pd-Pt) measured - 1.5V (D_2O disassociation). To elucidate the correlation between the EHG and the CV change, the excess energy and the CV are plotted as a function of the operation time (OT) in Fig. 6 and in Fig. 7,

respectively. The excess heat became appreciable beyond the error from about 120hr after the start of operation as clearly from Fig. 6, and the increase rate of the CV changed from linear to non-linear at about the same point of the OT as evidently from Fig. 7. The turning point at 120hr just corresponds to the IP of 23W as pointed out above. In Fig. 7, we plot the CV obtained from Run 4 as a typical example of the increase rate of the CV obtained from Run 4 as the case of no EHG. In the present five runs, only Run 3 gives such a non-linear change of the increase rate of the CV. This fact indicates that the non-linear change of the CV may have a significant correlation to the EHG.

The ENE was detected in all of the foreground runs (D_2O) in the present experiment as reported previously.3 To clarify the correlation between the EHG and the ENE, the foreground/background ratio of the neutron count rate and the excess energy obtained in Run 3 are plotted as functions of the OT in Fig. 8.

It may be concluded that the excess neutron intensity obtained here is so weak that we cannot find any clear correlation between the two effects.

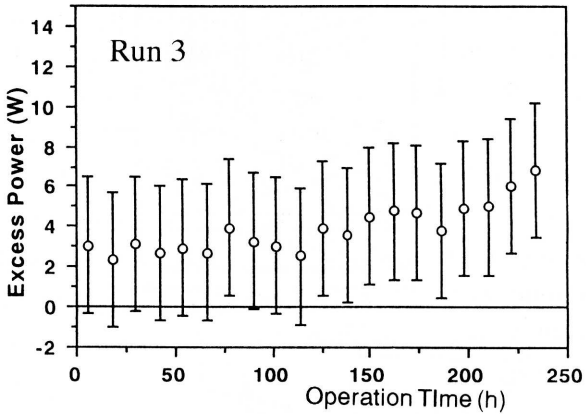

Figure 6. Excess power growth feature

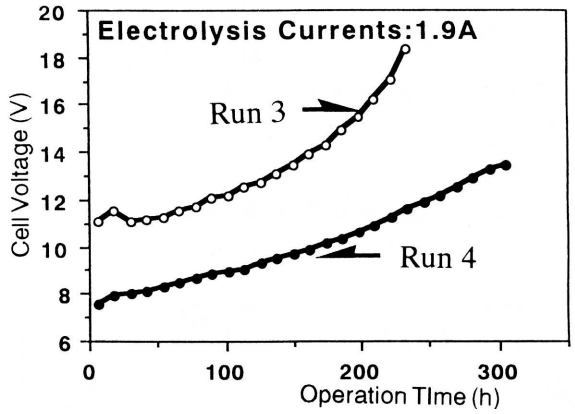

Figure 7. Increased rate of cell voltage

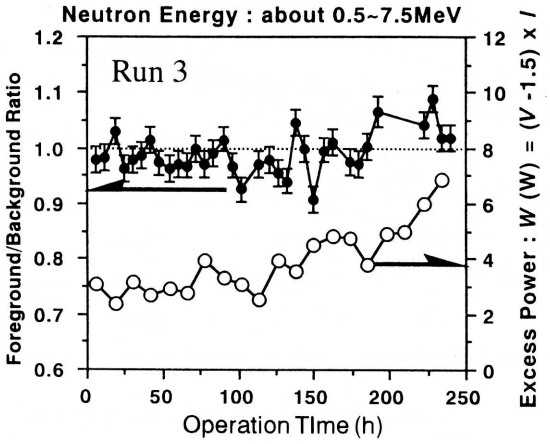

Figure 8. Correlation between excess heat generation and neutron emissions

CONCLUSION

To elucidate the correlation of the EHG with the ENE and the CV change, four foreground runs of D_2O-LiOD-Pd and one background run of H_2O-LiOH-Pd electrolysis were carried out using a Cell equipped a simple excess heat monitoring system.

From four foreground runs, weak but appreciable ENEs were detected, and from one of them the EHG was detected clearly. The correlation between the excess heat and the change of the increase rate of the CV was found to be clear, while the correlation between the EHG and the ENE was not yet clear.

For the further discussion, the conditions to replicate the non-linear increasing rate of the CV should be investigated to confirm the correlation to the excess heat generation, and to identify the conditions of the correlation to the EHG.

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